REPORT NO. 84-2-7 | 3430
ALEXANDRIA FIELD OFFICE | DECEMBER 1983

BIOLOGICAL EVALUATION OF INSECT DAMAGE AT THE STUART SEED ORCHARD, KISATCHIE NATIONAL FOREST (1983)

by

Julie C. Weatherby, Huey N. Wallace, and Robert W. Gaar[1/]

ABSTRACT

A seed orchard scouting program consisting of 5 visits was conducted during the 1983 growing season at the Stuart Seed Orchard, Pollock, Louisiana. Approximately 1,608 bushels of the 1983 cone crop and 4,510 bushels of the 1984 cone crop were predicted to be present in the Louisiana loblolly seed source as of September 1983. These crop estimates represent the survival of 81% of the 1983 crop from March 1982 to September 1983 and the survival of 88% of the 1984 crop from March 1983 to September 1983. Insects were the major identifiable agents causing losses to both crops. Forest Pest Management (FPM) recommends that a series of Guthion® 2S sprays applied via aircraft be continued in 1984.

INTRODUCTION

A seed orchard scouting program was initiated during 1982. This scouting program was designed to:

1) quantify the losses attributed to the major mortality agents
2) determine the periods when major mortality occurs
3) determine the effect these losses will have on the projected cone crop
4) identify areas where modification could be made to the current pest management strategy to better respond to pest pressures.

1/ Entomologist, Biological Technician, and Biological Aid, respectively, USDA Forest Service, Southern Region, State and Private Forestry, Forest Pest Management, Pineville, LA 71360.

A scouting crew from Forest Pest Management (FPM), Alexandria Field Office, monitored damage incidences and pest populations during the 1982 and 1983 growing seasons. During these visits data were compiled confirming that insects are the major identifiable agents causing losses in seed orchards (Overgaard et al. 1974) and, if not controlled, insect pests will adversely affect the availability of superior pine seed, thereby reducing future timber production (Barber 1982). Because there continues to be a demand for loblolly, slash, and longleaf seed, personnel from the Kisatchie National Forest are interested in maximizing seed production. Based upon the results of these evaluations, FPM recommends that a series of Guthion® 2S sprays applied via aircraft be continued in 1983.

METHODS OF EVALUATING INSECT POPULATIONS AND LOSSES

Pest management decisions are dependent upon accurate predictions and assessments of crop production levels (I), pest population levels (II), and associated damage levels (III). Three inventory-monitoring systems were implemented to quantify this information.

I. Assessment of Crop Production Levels

A. Selection of sample trees for inventory-monitoring system (Bramlett and Godbee 1982)

Sixteen clones of the Louisiana loblolly seed source were utilized as inventory clones. In 1981, 6 clones were selected from the high production class, 6 clones from the medium production class and 4 clones from the low production class. Three ramets were sampled from each of the inventory clones. Table 1 lists the selected clones, the number of ramets sampled, and the number of ramets of each clone within the seed source.

Samples were taken from ramets of 49% of the high producing clones, 44% of the medium producing clones, and 18% of the low producing clones.

B. Inventory procedures

The upper and lower crown of each sample tree was divided into quadrants. The average number of flowers per cluster for each of the eight areas of the crown was obtained by counting the number of flowers in four clusters located in each area of the crown and dividing by four.

Prior to conelet closure, all of the flower bearing clusters within each area of the tree crown were estimated. This number was multiplied by the average number of flowers per cluster and entered on the data sheet as a total tree count.

Table 1. Clones and the number of ramets sampled in each production class.

Clone	Production Classes					
	High		Medium		Low	
	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)
1	3	40				
5	3	47				
6	3	50				
11			3	53		
15	3	35				
16					3	39
19					3	51
22			3	46		
25					3	56
30	3	42				
34			3	51		
35					3	51
37			3	50		
42	3	50				
47			3	55		
49			3	55		
TOTAL	18	264	18	310	12	197

Eight branches selected in 1981, 1982, or 1983 were resampled in March, April, May, July, and September 1983, and the number of female flowers and 2nd year cones found on each tagged branch was recorded. During the first visit, new branches were selected for any missing tagged branches. If a tagged branch no longer contained any flowers or cones, the tag was removed.

II. Assessment of Key Pest Populations

The Stuart Seed Orchard contains loblolly, slash, longleaf, and shortleaf seed sources. While many of the insect pests feed as generalists on several pine species, a few pests prefer only 1 particular species. The following are key insect pests causing flower, conelet, and cone damage to the Louisiana loblolly seed source.

Leptoglossus corculus (Say)	Leaffooted pine seedbug
Tetyra bipunctata (H.-S.)	Shieldbacked pine seedbug
Dioryctria merkeli Mutuura & Munroe	Loblolly pine coneworm
Dioryctria amatella (Hulst)	Southern pine coneworm
Dioryctria clarioralis (Walker)	Blister coneworm
Dioryctria disclusa Heinrich	Webbing coneworm
Family Cecidomyiidae	Cone feeding midges

Currently there are no techniques to predict population trends for any of these pests. A few techniques are available which can detect the presence of certain pests.

A. Pheromone trapping for *Dioryctria* spp.

Pheromone trapping techniques are available for 4 coneworm species, *D. disclusa*, *D. clarioralis*, *D. merkeli*, and *D. amatella*. Because pheromone trapping for these species is a relatively new technique, a standardized trapping scheme has not been developed. In the interim, Forest Service Research recommended using 10 Pherocon 1C® traps baited with each pheromone. Traps were hung with a pulley system from an upper limb located within the top 10 feet of the crown. Twice a week orchard personnel checked the traps and recorded the number of male moths. Baits were changed monthly.

B. Visual searches for *Leptoglossus corculus* and *Tetyra bipunctata*

Attractive trapping methods are not available for either species of seedbug commonly found in seed orchards. Beginning in late March, visual searches were made of all branches sampled during the cone and seed inventory-monitoring system. The number of seedbugs sighted was recorded.

III. Assessment of Impact Caused by Key Pests

Data were gathered, which were used to generate impact estimates, by identifying causes of mortality for cones and conelets inventoried in the cone and seed inventory-monitoring system.

RESULTS AND DISCUSSION

I. Assessment of Crop Production Levels

Based upon the cone and seed inventory-monitoring system, approximately 1,608 bushels of cones were estimated to be present in the Louisiana loblolly seed source at harvest (1983). This estimate represents the survival of 81% of the original estimate made in March 1982. In addition, 4,510 bushels of cones (potential 1984 crop) are currently on the trees. This estimate represents the survival of 88% of the original estimate made in March 1983. Predictions based on a generalized survival curve indicate that approximately 3,472 bushels of Louisiana loblolly should be harvested in October 1984. Tables 2 and 3 summarize these predictions for the 1983 and 1984 crops, respectively.

The following assumptions were used to predict the size of the 1983 and 1984 cone crops.

1. Sample ramets are representative of all of the ramets of the selected clones.
2. Selected clones represent production levels of unsampled clones.
3. One bushel contains 325 cones.
4. One pound of seed can be extracted from a bushel of cones.
5. Potential estimates are based on the survival of 100% of the flowers or cones from each visit until harvest.
6. Predicted estimates are based on a generalized curve which predicts the crop size expected at maturity when mortality is considered (Bramlett 1982).

The orchard production in bushels of cones for the 1983 and 1984 cone crops are illustrated in figures 1A and 1B. The solid line on each graph represents the generalized curves compiled by Bramlett and Godbee (1982) for cone survival in a moderately managed orchard. The dashed lines represent the actual cone survival based upon periodic observations of tagged branches.

Table 2. Estimation, based on the inventory-monitoring system, of 1983 loblolly cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
April 1982			
Potential	643,504	1,980	1,980
Predicted	360,362	1,109	1,109
June 1982			
Potential	584,635	1,799	1,799
Predicted	392,537	1,208	1,208
August 1982			
Potential	577,997	1,778	1,778
Predicted	418,278	1,287	1,287
April 1983			
Potential	551,087	1,696	1,696
Predicted	456,888	1,406	1,406
May 1983			
Potential	538,821	1,658	1,658
Predicted	463,323	1,426	1,426
July 1983			
Potential	538,508	1,657	1,657
Predicted	476,193	1,465	1,465
September 1983			
Potential	522,669	1,608	1,608
Predicted	522,669	1,608	1,608

Table 3. Estimation, based on the inventory-monitoring system, of 1984 loblolly cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
April 1984			
Potential	1,657,783	5,101	5,101
Predicted	1,078,717	3,319	3,319
May 1984			
Potential	1,497,434	4,607	4,607
Predicted	995,739	3,064	3,064
July 1984			
Potential	1,487,041	4,576	4,576
Predicted	1,078,717	3,319	3,319
September 1984			
Potential	1,465,620	4,510	4,510
Predicted	1,128,504	3,472	3,472

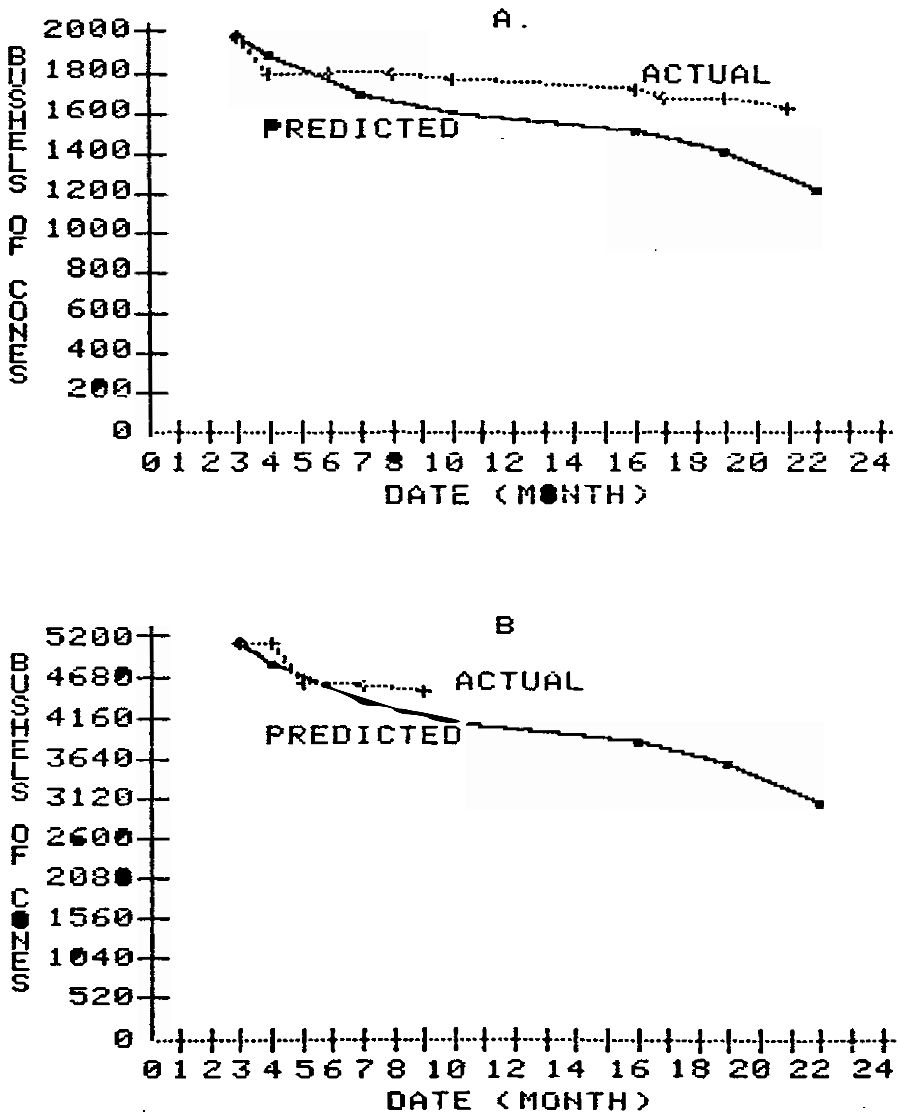


Figure 1. Actual and predicted survival curves, in bushels of cones, for the 1983 Louisiana loblolly cone crop (A.) and the 1984 Louisiana loblolly cone crop (B.).

II. Assessment of Key Pest Populations

Coneworm species - Dioryctria amatella - Southern Pine Coneworm
- D. clarioralis - Blister Coneworm
- D. disclusa - Webbing Coneworm
- D. merkeli - Loblolly Pine Coneworm

Biology - In the western zone of the Southern Region, greatest losses due to coneworms have been attributed to D. amatella (DA) and D. clarioralis (DC). These pests have multiple generations per year and, therefore, the potential exists for population buildup during the season.

Dioryctria amatella overwinters as an early instar larva and begins feeding on male and female flower buds. Later these larvae migrate to 2nd year cones where they pupate and emerge. Damage from the overwintering generation should occur prior to the first flight which usually begins in mid-April. The damage on 2nd year cones consists of dead or dying cones with entry holes surrounded but not enclosed by pitch and frass masses. The adult flights are not discrete. The pheromone traps capture moths in low numbers throughout the season.

Dioryctria clarioralis overwinters as a large larva and does little or no damage prior to the first adult flight in the spring (May). Three generations occur across most of the South. The larvae infest flowers, shoots, buds and young cones. The infested material is hollowed out and a distinctive blister of pitch-coated webbing covers the entry hole.

Two single generation pests, D. disclusa (DD) and D. merkeli (DM), are receiving considerable attention throughout the Southern Region. Dioryctria disclusa has caused heavy losses in certain orchards within the eastern zone. Pheromone trap catches indicate that the impact from D. merkeli may be more than previously expected.

Shoot attacks, particularly in slash pine, may be the earliest visible coneworm damage found during the spring. These attacks are usually attributed to D. merkeli. After overwintering as small larvae they move from shoots and flowers to

cones. These cones die prior to elongation without any evidence of external webbing. The larvae remain inactive throughout the summer, pupating and emerging in the fall. The adult flight usually begins in September and continues throughout October.

Dioryctria disclusa overwinters as a small larva and can be found in the male catkins in the spring. If populations are large, webbing becomes very noticeable within the catkins. When the catkins are dry the larvae migrate to 2nd year cones, often before control programs have begun. The cones die prior to elongation, and webbing and frass are present surrounding the entry hole.

Pest Status - Figure 2 is a graph of the 1983 pheromone data which Stuart personnel provided to George Ryan, Statistician, USDA-FS, Region 8, Atlanta, GA. The total trap catch (y-axis) is the sum of all males caught in the traps baited during the trapping interval. The trapping intervals have been expressed on a monthly scale. Table 4 is a ranking chart which ranks each orchard according to the total number of each species captured throughout the summer. The orchard and the total trap catch of each species has been high-lighted in 1 of 3 colors. These colors represent the following arbitrarily established potential loss classes: High (blue), >100 moths; moderate (green), 10-100 moths; and low (yellow), <10 moths. Data were received from 64 orchards. Orchards which reported "0 catches" were not ranked. The rank within the southeast for each species can be determined by following the high-lighted line to the left hand column.

The pest status and approximate dates of the adult flights for the 4 Dioryctria spp. have been summarized in table 5.

The 1983 catches of D. amatella and D. clarioralis declined from those reported in 1982. The D. disclusa catch increased slightly but the catch continues to be low. This report was written prior to the termination of the D. merkeli flight and, therefore, the total trap catch is not available. Based on the current

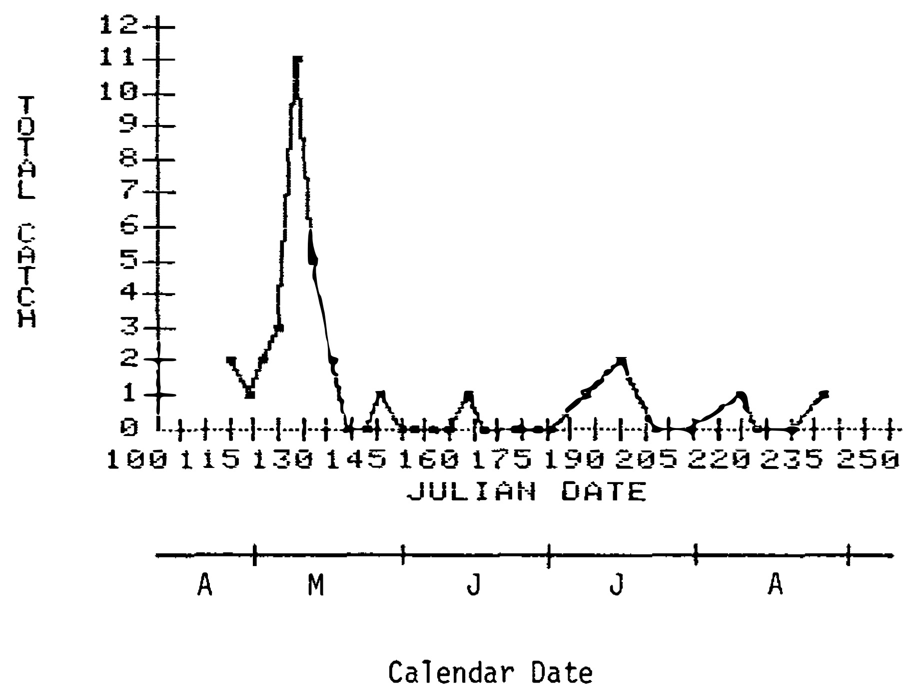


Figure 2. Graph of the 1983 pheromone trap catches of four coneworm species.

Table 4. Orchard rankings by total moth catch of four *Dioryctria* spp. included in the 1983 pheromone survey (March-August).

Rank	Orch.	No. of DC	Orch.	No. of DD	Orch.	No. of DM	Orch.	No. of DA
1	112	88	108	415	36	50	105	80
2	13	76	107	333	18	33	112	58
3	109	45	17	297	23	24	18	50
4	20	36	18	288	106	15	125	47
5	105	30	103	118	107	13	7	38
16	122	28	119	99	19	12	20	35
17	7	25	30	82	16	6	122	33
18	101	10	28	64	26	3	110	31
19	125	9	19	60	34	3	36	29
10	18	8	13	59	10	2	106	28
11	36	6	106	58	14	2	13	26
12	4	5	116	51	35	2	27	25
13	102	5	16	47	101	2	117	25
14	119	5	39	46	13	1	9	22
15	19	4	14	36	31	1	104	22
26	45	4	20	27	37	1	119	21
27	106	4	112	23	103	1	101	17
28	10	3	9	12	108	1	113	14
29	24	3	35	9	112	1	1	12
20	26	3	110	9	113	1	14	12
21	28	3	117	8	122	1	17	11
22	103	3	1	7			35	11
23	108	3	31	7			102	9
24	110	3	109	7			16	8
25	115	3	25	5			103	8
36	118	3	26	5			109	8
37	35	2	101	4			11	7
38	38	2	105	4			25	7
39	14	1	37	3			4	5
30	16	1	102	3			37	5
31	17	1	114	3			29	4
32	27	1	115	3			10	3
33	41	1	4	2			38	3
34	116	1	23	2			108	3
35			29	2			19	2
46			41	2			28	2
47			125	2			39	2
48			11	1			42	2
49			42	1			107	2
40							116	2
41							2	1
42							12	1
43							23	1
44							121	1

Table 5. Pest status and approximate dates of major *Dioryctria* spp.

Pest	Status	Dates of Peak Flights
D. disclusa	Low	June
D. merkeli	Unknown	
D. clarioralis	Unknown	
D. amatella	Moderate	Sporatic throughout the summer beginning late April

data, none of these species pose a serious threat.

<u>Seedbug Species</u> - <u>Leptoglossus corculus</u> (Say) - leaffooted pine seedbug

<u>Tetyra bipunctata</u> (H.-S.) - shieldbacked pine seedbug

<u>Biology</u> - The sizes of seedbug populations vary widely among seed orchards. Populations of leaffooted pine seedbugs are considered to be more destructive than populations of shieldbacked pine seedbugs.

Both species overwinter as adults. In the spring, <u>L. corculus</u> and <u>T. bipunctata</u> adults feed primarily on conelets. Apparently <u>L. corculus</u> adults mate and produce a new brood during spring and early summer. This generation is followed by another overlapping brood in July and August. <u>Tetyra bipunctata</u> eggs are seldom found prior to mid-July, indicating that the overwintering adults have produced their first brood. This brood matures resulting in the familiar increase in numbers found at harvest.

<u>Pest Status</u> - Prior to the September evaluation few seedbugs were sighted. During the September evaluation <u>Tetyra bipunctata</u> was the more numerous species. Based on the numbers sighted, a moderate population exists and little damage should have occurred in 1983. This population may represent a residual population with the potential to build to damaging levels in 1984.

<u>Other Pest Species</u>- <u>Contarinia</u> sp. - Loblolly pine needle midge

<u>Pest Biology</u> - Apparently this needle midge has multiple generations per year. Larvae are most prevalent in the new growth flushes, feeding underneath the fascicle sheaths. Damage is not apparent until the needles elongate and feeding scars become visible. During heavy infestations the needles droop at the fascicle and defoliation follows. Adult emergence and oviposition in the spring of 1984 is expected to correspond to the first flush of growth.

<u>Pest Status</u> - Outbreaks of this pest occur sporadically. One or two seasons of a moderate infestation level

probably will have little direct effect on the production or survival of the orchard ramets. However, severe damage may 1) provide numerous entry wounds for disease producing pathogens; 2) stress the tree, promoting the successful establishment of secondary insects; and 3) increase the effect of other physiological stresses.

The midge population during the last generation (fall 1983) was extremely large. Indications are that larval survival to the pupal stage was extremely high. Therefore, FPM anticipates a heavy infestation during the spring (1984).

III. Assessment of Impact Caused by Key Pests

The greatest cone losses occurred between July and September, 1983. During this period 4.26% of the cones (71 bushels) were damaged, destroyed or missing. These losses are probably tolerable losses. Very few cones were damaged or destroyed by coneworms. During the 1982 and 1983 seasons, coneworm-caused losses peaked after July. Most of this damage can be attributed to D. amatella. Populations of this multiple generation pest generally build during the summer, resulting in increasing damage levels. Table 6 summarizes this information.

Significant conelet losses occurred during the April - May interval (12.17% or 620 bushels). Approximately 8% of the conelets present during April were misssing by the end of May. This loss represents the combined effects of seedbug feeding, physiological abortion, inadequate pollination, disease, sampling error, etc. Minimal losses of conelets were directly attributable to insect feeding. Table 7 summarizes these data.

RECOMMENDATIONS

The predicted production at harvest for the 1983 crop represents the survival of 81% of the potential production estimated in March 1982. This exceeds the 60% crop survival rate for a moderately managed loblolly seed orchard described by Bramlett and Godbee (1982). In addition, conelet mortality of the 1984 crop was minimal (12%). Therefore, the 1984 Louisiana loblolly cone crop is expected to exceed 3,000 bushels. In order to realize this production goal, the 1984 pest management program must keep cone losses to a minimum. Six pest management alternatives are described in Appendix I. FPM recommends that the 1984 pest management strategy should consist of a series of Guthion 2S sprays (see Appendix I,

Table 6. Summary of cone mortality of the 1983 Louisiana loblolly cone crop.

Mortality Agents	No. of Dead Cones		% Mortality[1/]	
September 1982 - March 1983				
Coneworms	423		0.07	
Unknown	1,624		0.29	
Unknown Insect	812		0.14	
Missing	4,761		0.84	
Broken or Dead Branches	2,924		0.51	
TOTAL	10,544		1.85	
March - May 1983				
Unknown	1,023		0.19	
Missing	5,125		0.93	
Broken or Dead Branches	3,495		0.63	
TOTAL	9,643		1.75	
May - July 1983				
Coneworms	2,580		0.48	
Coneworm Damage		763		0.14
Unknown	2,838		0.53	
Unknown Damage	1,272		0.24	
Missing	2,866		0.53	
TOTAL	9,556		1.78	
July - September 1983				
Coneworms	13,200		2.45	
Coneworm Damage		5,438		1.01
Unknown	2,670		0.50	
Unknown Damage	2,014		0.37	
Missing	1,036		0.19	
Broken or Dead Branches	4,030		0.75	
TOTAL	22,950		4.26	

1/ % mortality was calculated based upon the number of cones alive at the beginning of each evaluation interval.

Table 7. Summary of cone mortality of the 1984 Louisiana loblolly cone crop.

Mortality Agent	No. of Dead Conelets	% Mortality [1/]
March - April 1983		
Unknown	1,092	0.07
TOTAL	1,092	0.07
April - May 1983		
Missing	132,305	7.98
Unknown	34,235	2.07
Unknown Insects	22,095	1.33
Broken or Dead Branches	13,057	0.79
TOTAL	201,692	12.17
May - July 1983		
Missing	37,319	2.49
Unknown	3,567	0.24
Unknown Insects	1,018	0.07
Broken or Dead Branches	1,068	0.07
TOTAL	42,972	2.87
July - September 1983		
Missing	28,967	1.95
Unknown	4,849	0.33
Broken or Dead Branches	4,941	0.33
Coneworms	1,141	0.08
TOTAL	39,898	2.69

1/ % mortality was calculated based upon the number of conelets alive at the beginning of each evaluation interval.

Alternative 4), applied via aircraft. In 1983 this alternative resulted in good conelet and cone protection.

In 1983 coneworms were the key pests of 2nd year cones. Assuming that the same species causing damage in 1983 continue to cause losses in 1984, FPM recommends using the 1982 and 1983 pheromone survey data along with a degree day concept to readjust application dates. Table 8 is the suggested spray schedule for 1984 at the Stuart Seed Orchard. Appendix II describes the procedures utilized in the construction of the Stuart spray schedule.

FPM is recommending that Guthin 2S be applied at a rate of 2 lbs of active ingredient per acre by aircraft. Suggested application parameters for fixed-wing and helicopter are listed below.

Parameter	Helicopter	Fixed Wing
Droplet size VMD (microns)	300-350	300-350
Nozzles	50 (D-02-25)	30 (D-06-46)
Boom pressure (PSIG)	40	40
Speed (MPH)	25	90
Swath width (ft)	30 or 60	30 or 60
Release height above trees (ft)	5	5
Adjuvant - Nalco-trol®	3 oz/100 gal H_2O	3 oz/100 gal H_2O

Table 8. Suggested insecticide spray schedule for 1984.

Application	Accum. °D	Calendar Date	Host Species
1	700	Early April	All
2	1,100	End April	All
3	1,600	End May	All
4	2,400	Mid-late June	All
5	4,200	Mid-late August	All
6	5,000	Mid-September	Longleaf Netted Areas

REFERENCES

Barber, L. R. An evaluation of insect damage in three southern federal seed orchards (1982). Rep. No. SA 82-1-21. Asheville, NC: U.S. Department of Agriculture, Forest Service, Forest Pest Management; 1982.

Bramlett, D. L.; Godbee, J. F., Jr. Inventory-monitoring system for southern pine seed orchards. Georgia Forest Research Paper #28, Georgia Forestry Commission.

Overgaard, N. A.; Flavell, T. H.; Drake, L. E. Seed orchard pest management in the south -- a problem analysis. U.S. Department of Agriculture, Forest Service, Southeastern Area, Forest Pest Management Group; 1974. 20 p.

Overgaard, N. A.; Wallace, H. N.; Hertel, G. D.; Stein, C.; Drake, L. E. Incidence of the Nantucket pine tip moth on shortleaf and loblolly pines in seed orchards treated with Furadan®, Cygon®, Di-Syston®, and fertilizers. Rep. No. SA 76-2-14. Pineville, LA; U.S. Department of Agriculture, Forest Service, Forest Pest Management Group; 1976. 33 p.

Pruess, K. P. Day-degree methods for pest management. Environ. Entomol. 12(3):613-619. 1983.

APPENDIX I

SEED ORCHARD PEST MANAGEMENT CONTROL ALTERNATIVES

Alternative 1. No action.

Benefits:

1) Lowers management costs
2) Encourages the natural buildup of beneficial insects and other predators
3) Reduces exposure of personnel to pesticides
4) Discourages the development of resistant strains of pests

Detriments:

1) Losses must be tolerated for indefinite periods of time
2) Pest populations may build to levels which cannot be tolerated before beneficial insects check the increase

Rationale: This alternative is usually selected when the value of the existing crop is less than the cost of the most inexpensive chemical control measure. As second generation orchards begin producing and as superior seed becomes available in storage, 1st generation orchards, or blocks within these orchards, may be placed on low maintenance. Under a low maintenance program, the "No Action" alternative will become an integral component.

Currently this option is of limited value. Young orchards which have not experienced pest population buildups are probably more efficiently managed without a structured spray program. Very few managers of producing orchards consider this a viable alternative.

Alternative 2. One Furadan® application.

Benefits:

1) Targeted at pests which feed on pine, not at beneficial insects
2) One application may reduce pest populations for several months

Detriments:

1) Furadan 15G has a high oral toxicity and must be incorporated into soil
2) High cost for a single application
3) Translocation is dependent upon adequate soil moisture
4) Efficacy decreases by midsummer
5) Application must be made in late winter or early spring when the ground is frozen or wet

Rationale: This alternative is usually considered for fairly well-drained orchards. Many orchards across the Southeast are too wet in late winter, and the application must be delayed. Applications made after mid-February will not effectively control early season pests. Apparently Furadan provides better protection of conelet crops than it does cone crops. If the flower crop is the featured crop, then a single Furadan application may be an effective strategy.

Orchard managers who have chosen this single application strategy must be willing to accept late season losses.

<u>Alternative 3.</u> Split Furadan application.

Benefits:

1) Targeted at pests which feed on pine, not at beneficial insects
2) One application may reduce pest populations for several months
3) Allows for flexibility in determining when Furadan will be effective

Detriments:

1) Furadan 15G has a high oral toxicity and must be incorporated into soil
2) High application and chemical cost
3) Translocation is dependent upon adequate soil moisture
4) Applications may be delayed because of ground conditions

Rationale: This alternative is usually considered in the same orchard where a single Furadan application would be effective. The treatments should be made approximately 6 weeks before the targeted pests are active or before the previous Furadan concentrations have dropped below the lethal concentration (LC). This alternative may allow you to extend the protection associated with Furadan throughout the growing season. In theory, this alternative has potential. However, the inconsistencies associated with Furadan uptake and

translocation probably will make the double application even more inconsistent.

Timing is an important consideration. If the first application is targeted for early season pests, then the standard mid-February application will probably be timely for this first application. Furadan usually dissipates by mid to late summer. Therefore, a second application should be applied in late May or early June.

The 2nd important consideration is the application rate. The current label allows for application of from 2.7 - 5.3 oz. of Furadan 15G for each inch of tree diameter. In a split application, two 2.7 oz. applications should be effective if uptake is sufficient.

Preliminary results indicate that split applications of Furadan used alone do not adequately increase protection over a single application (Overgaard 1976). Additional modifications could be considered but the most important consideration is the benefit:cost of 2 applications as opposed to a single application.

Alternative 4. Three to six sprays of Guthion® or Pydrin®.

Benefits:

1) Multiple sprays allow flexibility in timing applications
2) Frequency of applications can reflect insect damages and/or population levels
3) Flexibility in method of application (ground, air)

Detriments:

1) Labor intensive
2) Excessive exposure of personnel to restricted use pesticide
3) Ground applications may be delayed by excessive soil moisture
4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative allows more responsiveness to insect population levels and flexibility in targeting an application to coincide with the life cycle of the pests. Guthion and Pydrin are the only chemicals currently registered for coneworm control which can be applied monthly, throughout the summer, at the recommended rates.

The most widely used formulation of Guthion is the 2S formulation. The 2S formulation does not crystalize when

stored below freezing. In addition, the 2S formulation as compared with the WP formulation can be applied with less wear to spraying equipment. However, the WP formulation has a longer residual than the 2S formulation. It may be advantageous to utilize the advantages of each formulation and use the WP formulation in spring when rainfall is heavy, switching to the less abrasive formulation in the summer and fall.

Pydrin is a synthetic pyrethroid with a low mammalian toxicity. Exposure of orchard personnel to Pydrin is much less hazardous than exposure to Guthion. In addition, Pydrin remains at effective concentration for longer periods than Guthion 2S.

The application schedule is extremely important. Applications should be made just prior to the periods when the greatest damages occur. The first spring application usually is made during the week following pollination. This application coincides well with the period when major conelet losses occur and when early coneworm caused losses are beginning. Subsequent sprays are often applied at monthly intervals following the initial spray. If the orchard manager has adequate information to identify and monitor the key pests, then the applications can be targeted for the susceptible stages of the key pests. Currently the technology to monitor and time sprays is limited.

Alternative 5. Furadan combined with supplementary sprays.

Benefits:

1) Insures the orchard is protected during the entire season
2) Increases the suppression efforts against coneworms
3) Early spray applications serve as a backup to Furadan if uptake is minimal

Detriments:

1) Furadan 15G has a high oral toxicity and must be incorporated into soil
2) Translocation is dependent upon adequate soil moisture
3) Application must be made in late winter or early spring when the ground is frozen or wet
4) Labor intensive
5) Ground applications may be delayed by excessive soil moisture
6) Pest management costs are increased substantially
7) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is becoming increasingly popular with industrial orchards. Often the size of the area to be treated is the limiting factor.

If Furadan uptake is sufficient, conelet survival is increased substantially. The highest Furadan concentrations are usually found in the actively growing shoots, making Furadan an ideal pesticide for early season shoot infesting pests such as tip moths. Furadan appears to be less effective against coneworms, damaging 2nd year cones. Therefore, backup sprays increase the suppression efforts targeted for coneworm control. Both pesticides are usually effective against seedbugs.

The major concern when choosing this alternative is timing the supplementary sprays to obtain maximum protection for the increased management costs. If the orchard has a history of early season pests, particularly 1st generation coneworms (*Dioryctria disclusa*, etc.), it may be desirable to apply a pesticide 6 days after peak pollen flight. Beginning in mid-May or early June, 2 to 4 additional sprays should protect 2nd year cones against increasing coneworm populations. If cones are harvested using the traditional hand picking procedures, the last spray would probably be applied 2 or 3 weeks before harvest. If netting is used to harvest seed, the last spray can be delayed to suppress increasing populations of both seedbugs and coneworms.

The choice of insecticides is limited. Currently 2 insecticides, Pydrin and Guthion, are registered for coneworm and seedbug control. Pydrin is an ideal chemical for spray applications during periods when orchard personnel are active within the orchard and during periods when a longer residual is needed. Therefore, spring and fall would be ideal times for Pydrin applications while Guthion might be applied in midsummer. This combination of insecticides, Furadan, Guthion, and Pydrin, should help eliminate many of the sucking insect problems associated with the use of Pydrin and Guthion applied by aerial application.

Alternative 6. Three to six sprays of mixed chemicals.

Benefits:

1) Multiple sprays allow flexibility in timing applications
2) Frequency of applications can reflect insect damages and/or population levels
3) Flexibility in method of application (ground, air)
4) Decreased potential for resistant pest populations
5) Less exposure to highly toxic chemicals

Detriments:

1) Labor intensive
2) Excessive exposure of personnel to restricted use pesticide
3) Ground application may be delayed by excessive soil moisture
4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is very similar to Alternative 4. It is usually advantageous to alternate chemicals rather than to depend on one chemical. Alternate applications of chemicals, with different modes of actions, tend to decrease the development of resistant pest populations. Currently, Pydrin and Guthion are the two registered chemicals which fit well into a spray schedule. Hydraulic, mist blower, and aerial applications of both chemicals have been demonstrated to effectively suppress coneworm and seedbug populations. The characteristics of each chemical have been described under the rationale section of Alternative 4. These characteristics should help determine when each chemical should be applied.

APPENDIX II

PROCEDURE UTILIZED IN THE CONSTRUCTION OF THE STUART SPRAY SCHEDULE FOR CONEWORM SPECIES

Step 1 - Calculate the average degree day accumulations for the Stuart Seed Orchard from five years of NOAA maximum and minimum temperatures (°F) recorded for Alexandria, LA.

Average daily maximum and minimum temperatures (°F) were calculated from five years of NOAA data. Daily degree days were computed by the mean-minus-base method (Pruess 1983). These values were accumulated on a daily basis starting January 1. Table 9 lists the average degree day accumulations for five day intervals.

Step 2 - Rescale the 1982 and 1983 pheromone survey data, for the Stuart Seed Orchard, from calendar dates to degree days.

Daily maximum and minimum temperatures for 1982 and 1983 were obtained from Kisatchie National Forest. Degree days were computed and accumulated from January 1. Total trap catches on designated sample days were listed with the corresponding degree day accumulations. The paired degree day accumulations and the total trap catches for 1982 and 1983 are plotted in figure 3A and 3B, respectively.

Step 3 - Compile historical information concerning approximate adult flights for Stuart Seed Orchard and other orchards within the Southeast.

Light trap catches for all coneworm species for 1978 and 1979 were plotted on a degree day scale in figure 4A and 4B, respectively.

Step 4 - Predict the approximate flight periods by identifying the calendar date when the average day degrees accumulation approaches the day degrees accumulated during adult flights.

Figure 5 combines the pheromone trap data (1982 & 1983) with the light trap data (1978 & 1979). Several flight peaks are evident. Suggested degree day accumulations for five sprays are indicated by arrows (▼). An optional spray for longleaf and area harvested with netting is indicated with a star (★). Locate the average degree day accumulations of suggested sprays in table 9. Sprays should be tentatively scheduled on calendar dates associated with degree day accumulations.

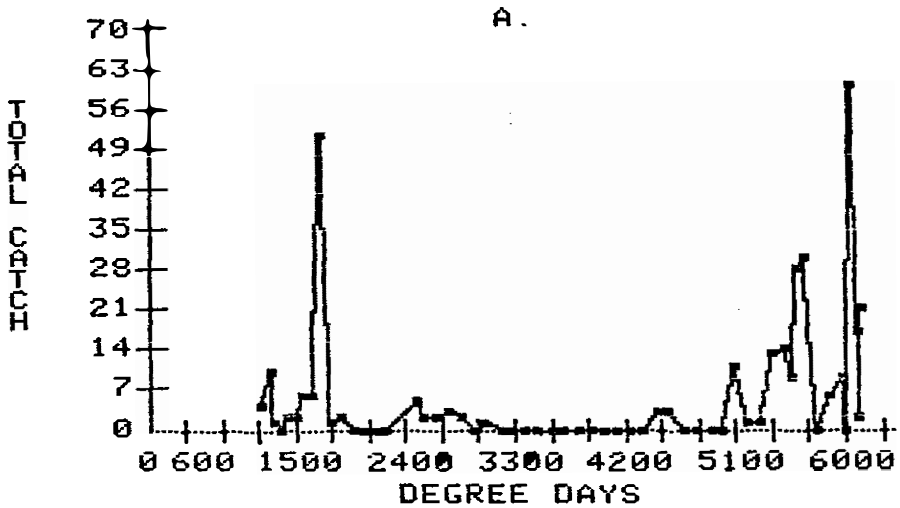
Step 5 - Determine spray dates targeted at maximum hatch.

Suggested Spray Schedule -

Application	Date	Species
1	Early April - 700 °D	All
2	End April - 1,100 °D	All
3	End May - 1,600 °D	All
4	Mid-late June - 2,400 °D	All
5	Mid-late August - 4,200 °D	All
6	Mid-September - 5,000 °D	Longleaf, Netted Areas

Table 9. Average degree day accumulations calculated from five years of NOAA data.

Date	Accum. °D	Date	Accum. °D
Jan. 5	1	June 4	1952
10	17	9	2110
15	19	14	2254
20	43	19	2411
25	74	24	2563
30	100	29	2697
Feb. 4	126	July 4	2853
9	130	9	2997
14	148	14	3149
19	170	19	2411
24	197	24	2563
March 1	234	29	2697
6	272	Aug. 3	3783
11	345	8	3932
16	398	13	4092
21	464	18	4251
26	514	23	4409
31	583	28	4562
April 5	636	Sept. 2	4712
10	700	7	4836
15	790	12	4989
20	873	17	5126
25	966	22	5258
30	1073	27	5384
May 5	1175	Oct. 2	5489
10	1288	7	5587
15	1412	12	5698
20	1548	17	5796
25	1689	22	5865
30	1825	27	5930



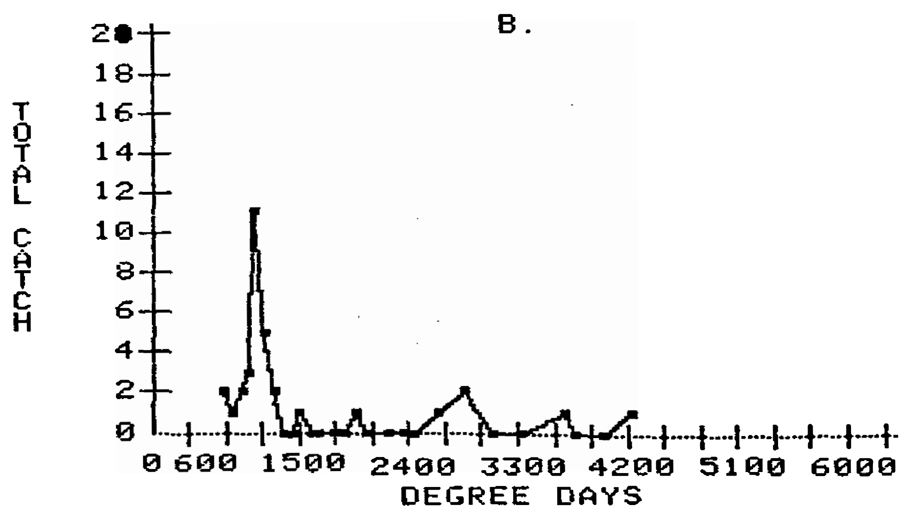


Figure 3. Graphs of the 1982 (A.) and 1983 (B.) pheromone trap catches of four coneworm species.

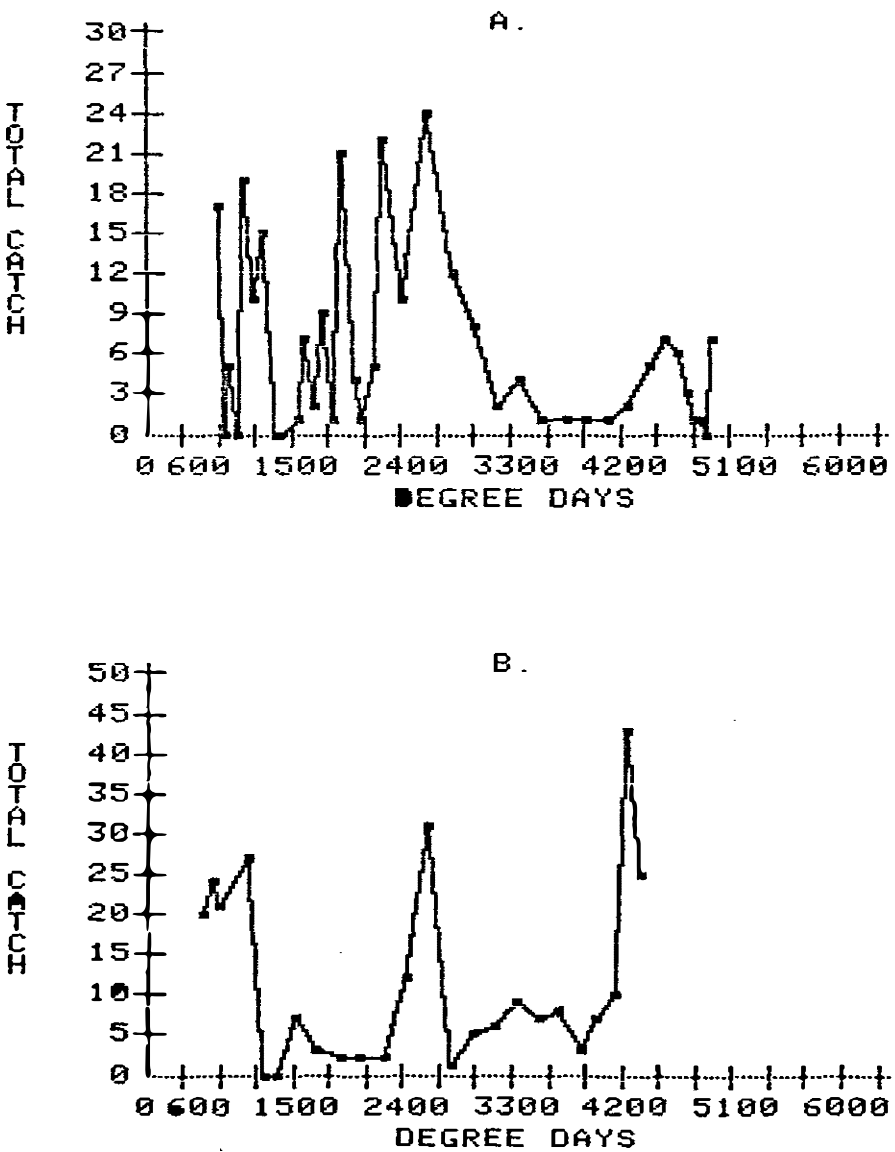


Figure 4. Graphs of the 1978 (A.) and 1979 (B.) light trap catches of four coneworm species.

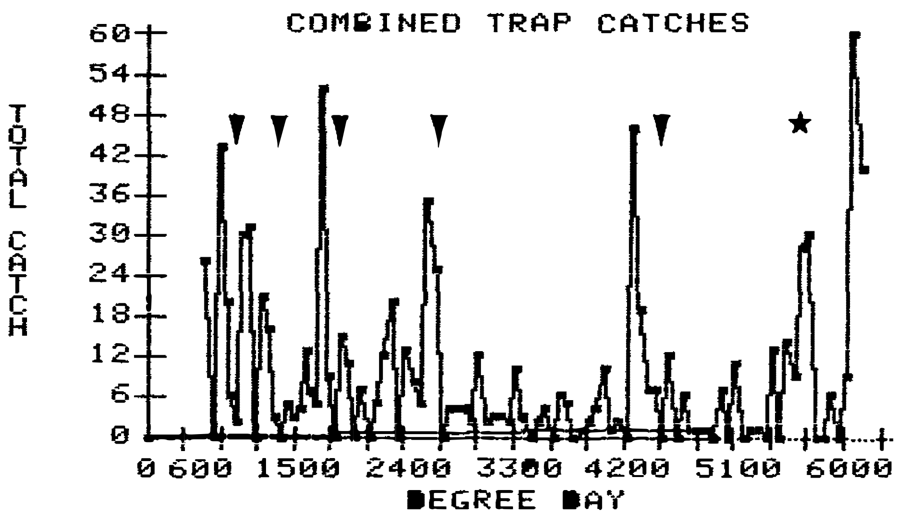


Figure 5. Combined pheromone trap data (1982 and 1983) and light trap data (1978 and 1979) plotted on a degree day scale. (▼ suggested sprays, ★ optional spray)

PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in their original containers under lock and key out of reach of children and animals, and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear appropriate protective clothing.

If your hands become contaminated with a pesticide, wash them immediately with soap and water. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove the clothing immediately and wash skin thoroughly. After handling or spraying pesticides, do not eat or drink until you have washed with soap and water.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicide from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your county agent, state extension specialist or FPM to be sure it is still registered for the intended use. For further information or assistance, contact Forest Pest Management, Alexandria Field Office, Pineville, La., 71360, (Telephone: FTS 497-7280, or Commercial 318/473-7280).

REPORT NO. 84-2-7
ALEXANDRIA FIELD OFFICE

3430
DECEMBER 1983

BIOLOGICAL EVALUATION OF INSECT DAMAGE AT THE STUART SEED ORCHARD, KISATCHIE NATIONAL FOREST (1983)

Prepared by: Julie C. Weatherby
Entomologist

Huey N. Wallace
Biological Technician

Robert W. Sear/jcw
Biological Aid

Approved by: Paul A. Mistretta
for HARVEY V. TOKO
Staff Director
Forest Pest Management

SOUTHERN REGION, STATE AND PRIVATE FORESTRY
USDA, FOREST SERVICE, ATLANTA, GA 30367